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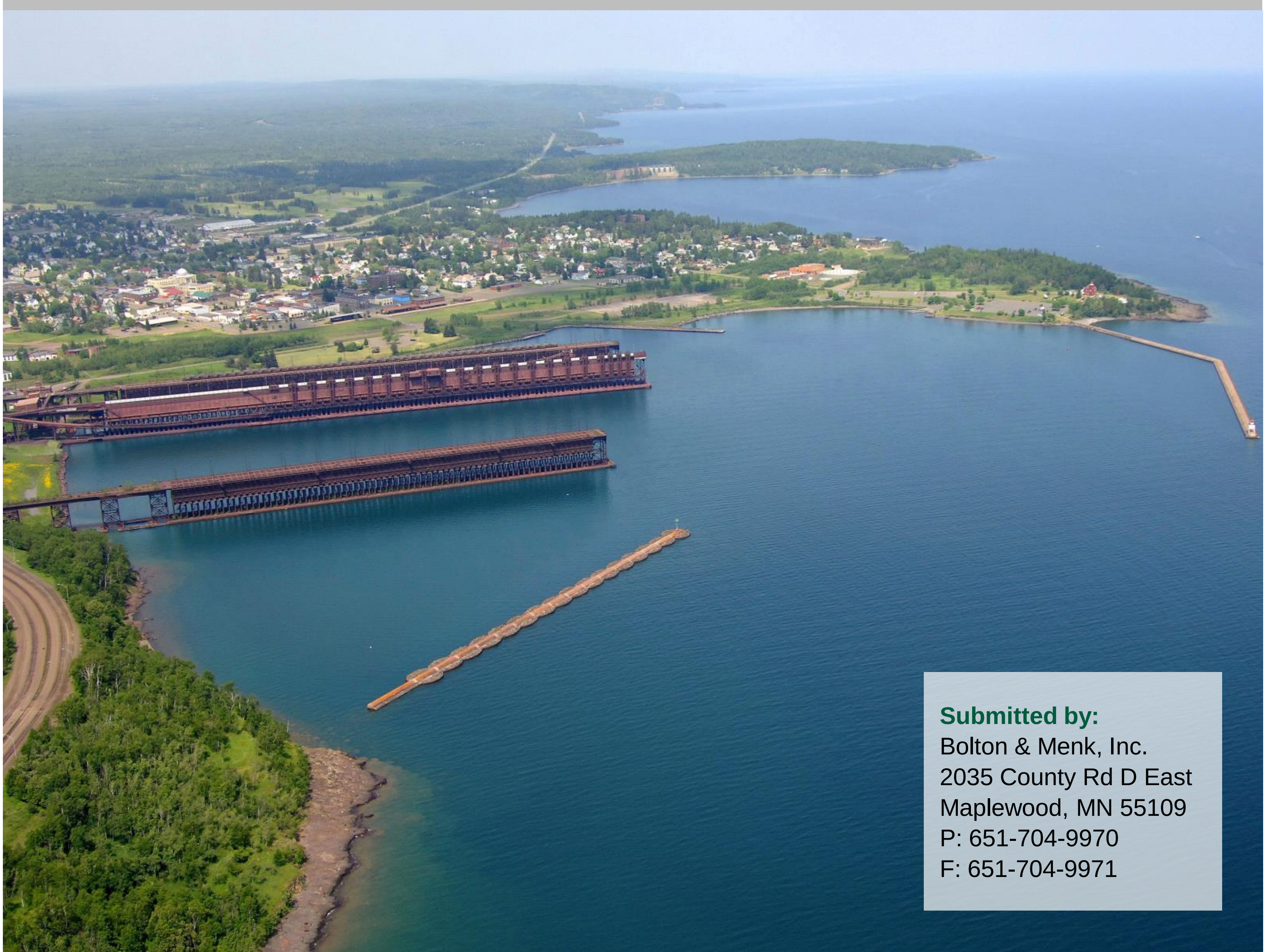
Stormwater Management Plan
City of Two Harbors, MN

March 2021



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Certification

Stormwater Management Plan

For

City of Two Harbors, MN

BMI Project No. U16.122412

March 2021

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

By: Timothy J. Olson

Timothy J. Olson, P.E., CFM
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Date: 03/24/2021

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I. Executive Summary

This report provides the City of Two Harbors with a guide for stormwater activities in the City and will serve as a tool to protect, preserve, and enhance its water resources. Periodic amendments to the plan will likely occur so that the plan remains current to the rules and regulations of the governing agencies, is updated with city and county capital improvement planning, is modified as funding opportunities change with constructed practices, and evolves with Lake County Soil and Water Conservation District project planning. The goals of this Stormwater Management Plan include the following.

1. Assess current drainage infrastructure through hydraulic modeling.
2. Identify stormwater quantity and quality improvement projects.
3. Develop preliminary infrastructure installations necessary to minimize impacts to its critical waterbodies.
4. Develop anticipated project costs and identify funding opportunities.

The plan investigates the potential for stormwater best management practices (BMPs) focused on improving the water quality of the City's water resources including Skunk Creek, Segog Creek, Agate Bay, and Lake Superior. Bolton & Menk, Inc. partnered with Lake County Soil and Water Conservation District (Lake SWCD), the City of Two Harbors, and the Army Corp of Engineers to complete this assessment.

Locations for several different forms of BMPs were identified and modeled for water quality improvements and preliminary cost estimates were prepared for each BMP. The cost estimates were compared to the expected pollutant removal levels to generate a cost benefit assessment. Potential locations were identified through discussions with the City of Two Harbors and Lake SWCD, aerial photography, light detection and ranging (LiDAR), as-builts, and survey. Recommended strategies were proposed based on the environmental, economic, and social benefits to the City.

This report describes the strategies, results, and economic benefits for treating stormwater runoff to the City of Two Harbors critical waterbodies but does not provide a full feasibility report for the more complicated BMPs that are proposed. Additional information and analysis are required before implementation can be considered.

The following BMPs are proposed to improve the water quality of the City's natural resources:

Proposed BMP Type	Proposed BMP Location	Anticipated Costs
Hydrodynamic Separator and Debris Separating Baffle Box	Associated with City and Lake County Roadway Projects	\$35,100 - \$93,200
Biochar Filtration Basins	Agate Bay, City and DNR Properties	\$105,300 - \$234,000
2-Stage Ditch	City and DNR Properties	\$263,660 - \$585,820
Pond Restoration/Cleaning	Cemetery, stormwater basin circa 2004	\$89,100
Pond Outlet Repair	Harbor Hills stormwater pond circa 2003	\$24,340
Streambank Stabilization	Various locations along Skunk Creek	ACOE to Provide

II. Introduction

A. History

The City of Two Harbors is located in the southwest corner of Lake County, roughly 26 miles northeast of Duluth. The City occupies an area of approximately 3.3 square miles and has a population of 3,745 residents. The major natural surface water features of Two Harbors are Lake Superior and the surface waters that drain to Lake Superior, including Skunk Creek, Segog Creek, Golf Course Creek, and Pete's Creek. Refer to **Figure 1** for a general location map.

Two Harbors was settled in the 1850's after the signing of the Treaty of Lapointe. In the 1880's the area experienced rapid growth with the expansion of the iron ore industry and the construction of the Ore docks in Agate Bay. In the 1960's, United Steel shut down operations in Tower and the population of Two Harbors declined as workers left for employment elsewhere. Today the City is host to an abundance of outdoor recreational activities and tourism related businesses including shops, restaurants, and hotels. The City is passionate about the preservation and management of its natural resources, continuing to be stewards for Lake Superior and the surrounding watershed.

Skunk Creek is currently listed as impaired for total suspended solids (TSS) and E. coil bacteria (Lake Superior South Watershed TMDL Report, 2019). Agate Bay has seen impacts to aquatic recreation due to the E. coli impairment.

B. Project Background

Two Harbors faces many challenges that come with a community that was built in the late 1800's and into the early 1900's including aging infrastructure, flooding, erosion, and water quality. Additionally, there is a public health concern identified by the Minnesota Department of Health that has shown levels of E. Coli above the standard in Skunk Creek and Agate Bay, resulting in beach closures throughout the year. Through coordination with the City of Two Harbors, and the Lake County Soil and Water Conservation District (SWCD), critical water quality improvement projects have been identified to help improve and mitigate the water quality impairments of the City's valuable water resources. This stormwater management plan will outline the critical water resources, propose water quality projects to improve and mitigate water quality impairments, and aid in prioritizing projects to help align with the City's future CIP and funding opportunities. It will also provide a framework for future funding with numerous potential project partners.

Stormwater Management Plan
Two Harbors, MN

Regional Location Map
January 2021

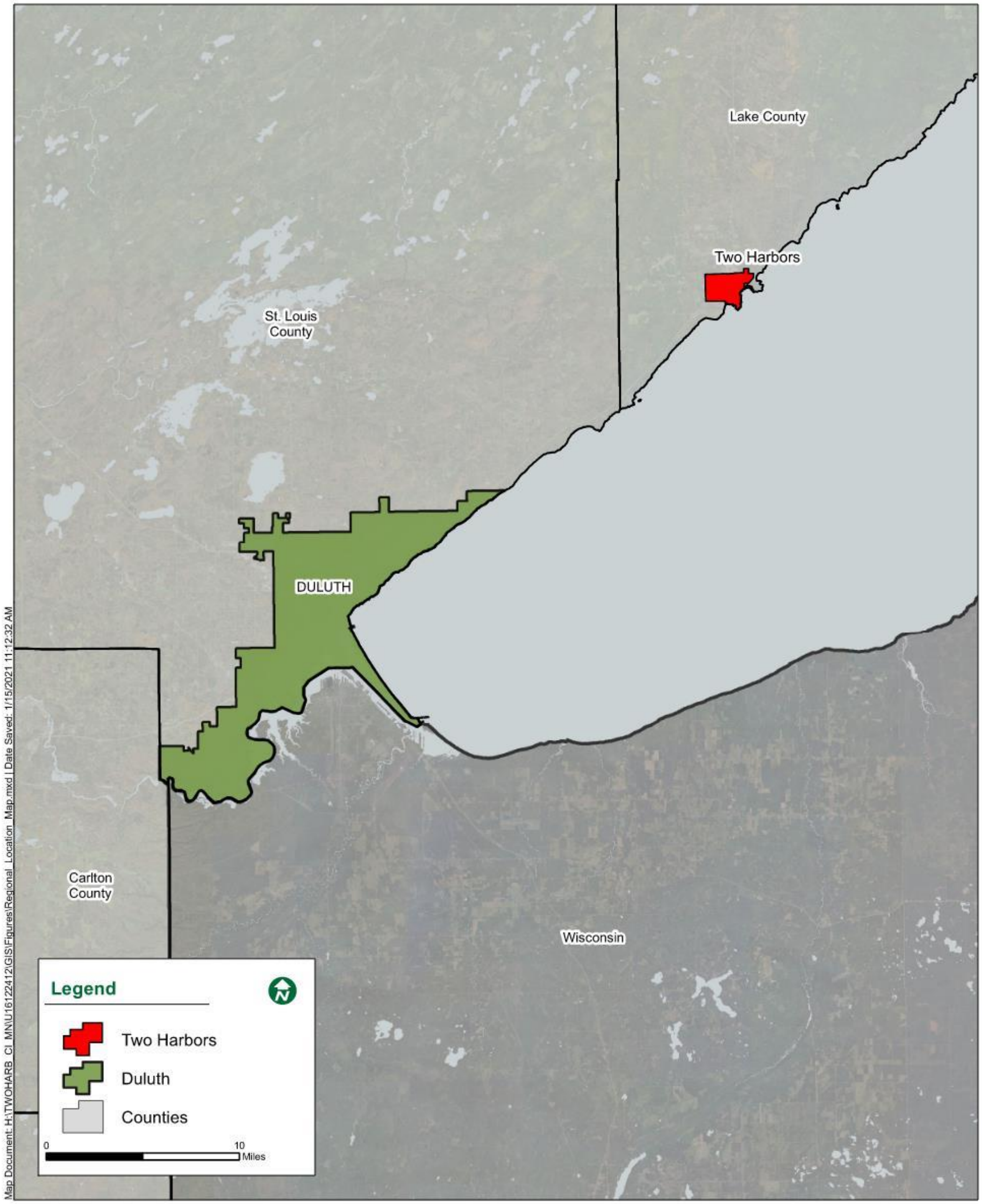


Figure 1: Regional Location Map

C. Past Studies

The Two Harbors Stormwater Management Plan is predicated on numerous studies that have addressed project planning, identification of natural resource pollutant sources, and natural resource protection.

i. Two Harbors Comprehensive plan (August 2015): Tourism, cultural, recreation, and natural resources outlines the goals and action steps to ensure the protection and preservation of key environmental resources.

ii. Stream Bacterial Impairments Rapid Assessment (February 2019): Memorandum identifies potential sources of E. Coli that are responsible for the high levels of E. Coli in Skunk Creek, Agate Bay, and Burlington Bay.

iii. Lake Superior South Watershed TMDL Report (2019): The TMDL report includes assessments for aquatic life impairments for TSS and aquatic recreation impairments for E. coli.

iv. Storm Water Management Plan for City of Two Harbors (2001): Chapter 1.2 outlines the goals and policies of the City regarding future projects, funding, stormwater runoff quality and quantity, and protecting the City's valuable water resources.

D. Data Sources, Hydraulic Modeling and Analysis

The City of Two Harbors has an archive of as-built plans that include public utilities, zoning, and additional development information. In addition, TSA conducted a survey of any additional missing information regarding storm sewer structure elevations and pipe sizes.

The as-built plans were coupled with the survey collected by TSA to develop a regional hydraulic model of the storm sewer system to identify problem areas related to storm sewer capacity and open channel flow. Hydraulic modeling extents are shown in **Figure 2**.

Light detection and ranging (LiDAR) surface topography is utilized for the regional elevation assessments in lieu of more refined topographic survey.

E. Goals & Objectives

The goals and objectives of the SWMP for the City of Two Harbors are as follows:

1. Develop an understanding of the existing storm sewer infrastructure through the compiling of as-built plans and additional storm sewer infrastructure survey data.
2. Develop a regional hydraulic model updated with Atlas 14 rainfall depths and MSE 3 rainfall distribution.
3. Utilize the regional hydraulic model to identify critical problem areas.
4. Propose water quality improvements.
5. Define project costs and identify potential funding.

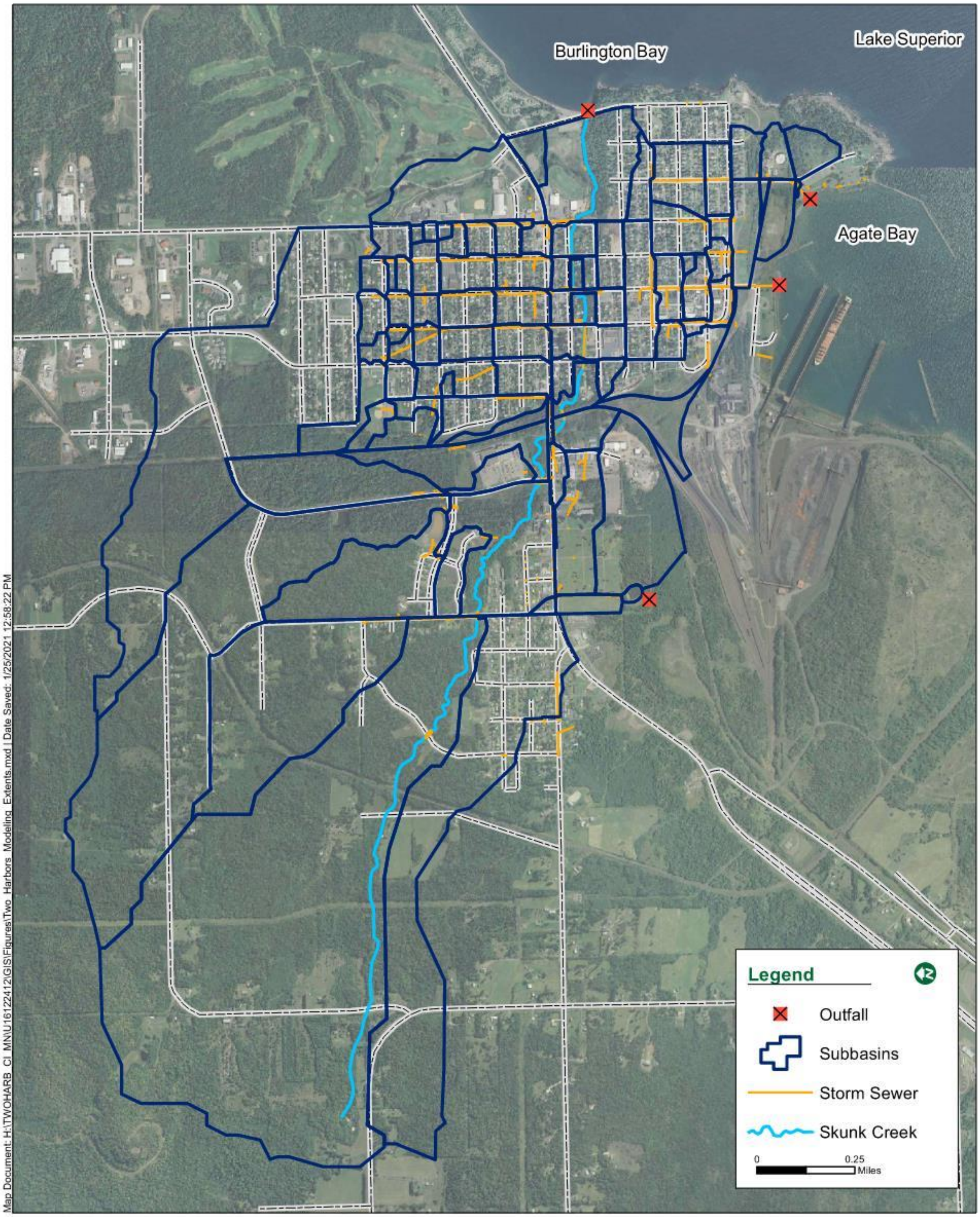


Figure 2: Modeling Extent

III. Existing Conditions

A. Key Surface Waters

Surface water management is a strong component of the City's overall approach to protecting and preserving the community's natural resources. The City of Two Harbors recognizes the value and impact that surface water can have on the quality of life in the community. Surface water management also includes the infrastructure designed and constructed to collect, convey, store, treat, control and protect surface water resources.

1. Skunk Creek

Skunk Creek is a valuable resource that flows through downtown Two Harbors and discharges into Lake Superior. The Creek drains approximately 1400-acres of primarily forested and urban land. The characteristic of the Creek changes throughout its flow length and can be divided into 3 distinct reaches which will be referred to as Exurban, Suburban, and Urban. The Skunk Creek watershed boundary and distinct reaches are shown in **Figure 3** below.

Exurban – The headwaters of the Creek start northwest of Two Harbors outside of city limits. The tributary area to this section is largely unsewered lots, with some agricultural and commercial uses. This section of the Creek is not well defined and was observed to be divided into two primary channels once it reaches the railroad tracks adjacent to Bourdage Road. The northern channel is one that shows a deeply incised channel, while the southern channel demonstrates a meandering channel with an adjacent floodplain.

Suburban – downstream of the Exurban section, the Creek flows south of the Hidden Springs residential development before passing under 7th Ave into downtown Two Harbors. There are a handful of stormwater basins that discharge stormwater into the Creek from the Hidden Springs development, Harbor Hills development, Super one Foods, and residential roads. The banks are generally steep and unstable with little floodplain adjacent to the channel.

Urban – downstream of 7th Ave crossing, the Creek that passes into downtown Two Harbors. This section of the Creek has seen the most alterations. The Creek is characterized by stream bank erosion in addition to hardening of the stream bank and bed. Portions of the Creek channel are routed through large box culverts located under residential areas and roadways. This section of the Creek has shown historical evidence of flooding.

2. Agate Bay / Lake Superior

Agate Bay contains an ore dock that was constructed in the 1880's and still serves as an active port today. The Bay is frequented by tourists who are attracted to the bay's beaches and historic lighthouse. Agate Bay has impairments for E. Coli and turbidity. Water quality monitoring has identified biological contaminants that have resulted in beach closures. Stormwater runoff south of 4th Avenue is collected by storm sewer and routed into Agate Bay. In addition, the effluent from the Two Harbors wastewater treatment plant discharges into the Bay.

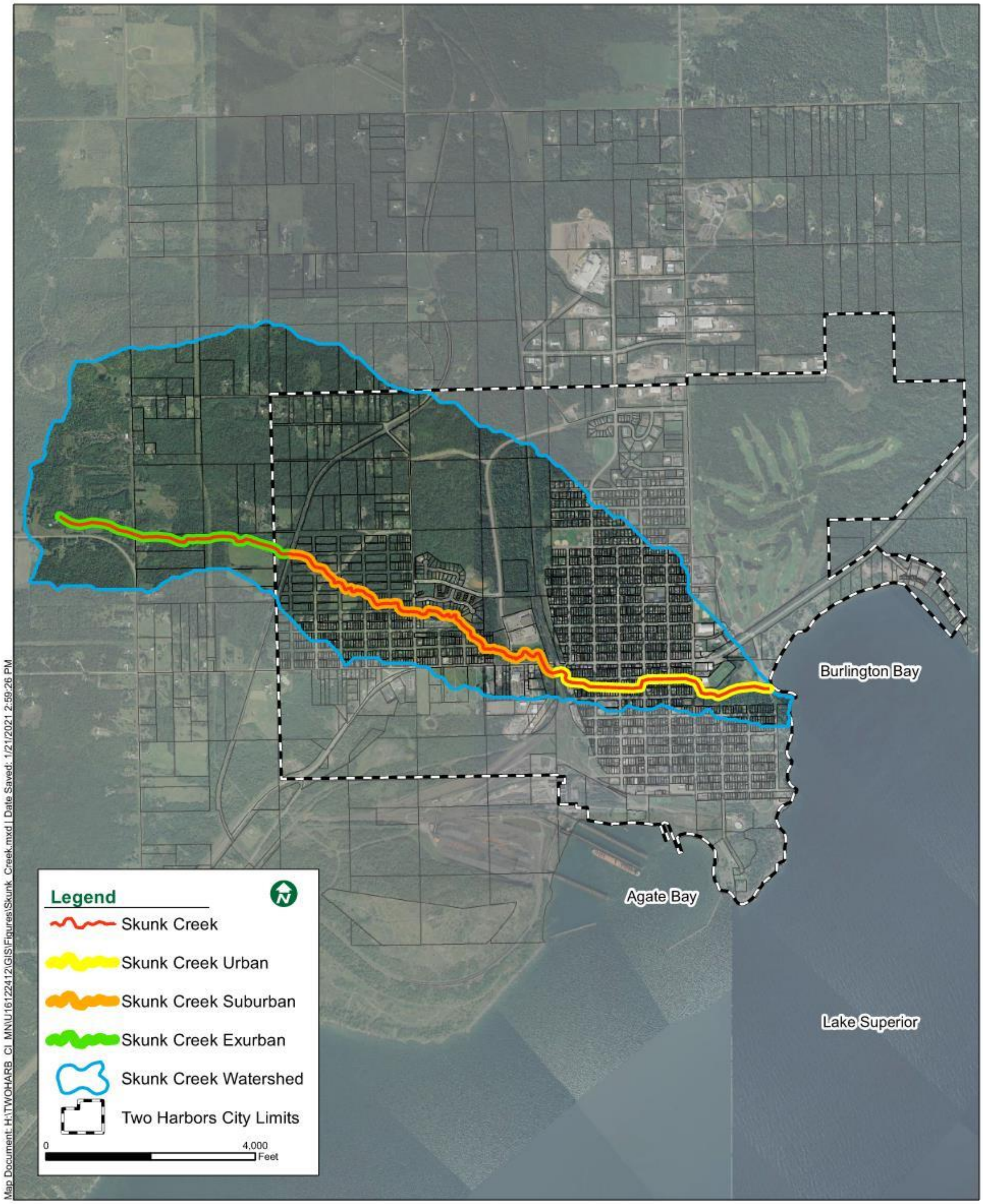


Figure 3: Skunk Creek Watershed

B. Surface Water Impairments

According to the Minnesota Pollution Control Agency, Skunk Creek has an EPA-approved impairment for Escherichia Coli and Turbidity. In 2019, Emmons & Olivier Resources, Inc. conducted a Stream Bacterial Impairments Rapid Assessment for the Skunk Creek drainage area. The assessment was conducted in response to numerous samples collected by the Minnesota Department of Health that showed levels of E. Coli that were above the standard, resulting in numerous beach closures throughout the year. The assessment investigated three main potential sources for E. Coli including Non-compliant Septic Systems Fecal Sources, Livestock and Wildlife Fecal Sources, and Pet Fecal Sources.

Additionally, the City is aware of the potential for combined sewers, and illicit storm sewer connections. These connections were likely made during the original construction of the houses, storm sewer, and sanitary sewer, before the 1972 Clean Water Act. The lack of regulation during this time period meant that a home's plumbing could be very unorthodox compared to today's standards. Illicit connections are not uncommon and can be very difficult to detect. For example, a house could have one sanitary line that connects to the sanitary sewer, and a basement bathroom that is connected to the homes drain tile. The drain tile connects directly into the City's storm sewer and would discharge into the City's water resources untreated. The City has been working to identify and address these connection issues during their capital improvement projects.

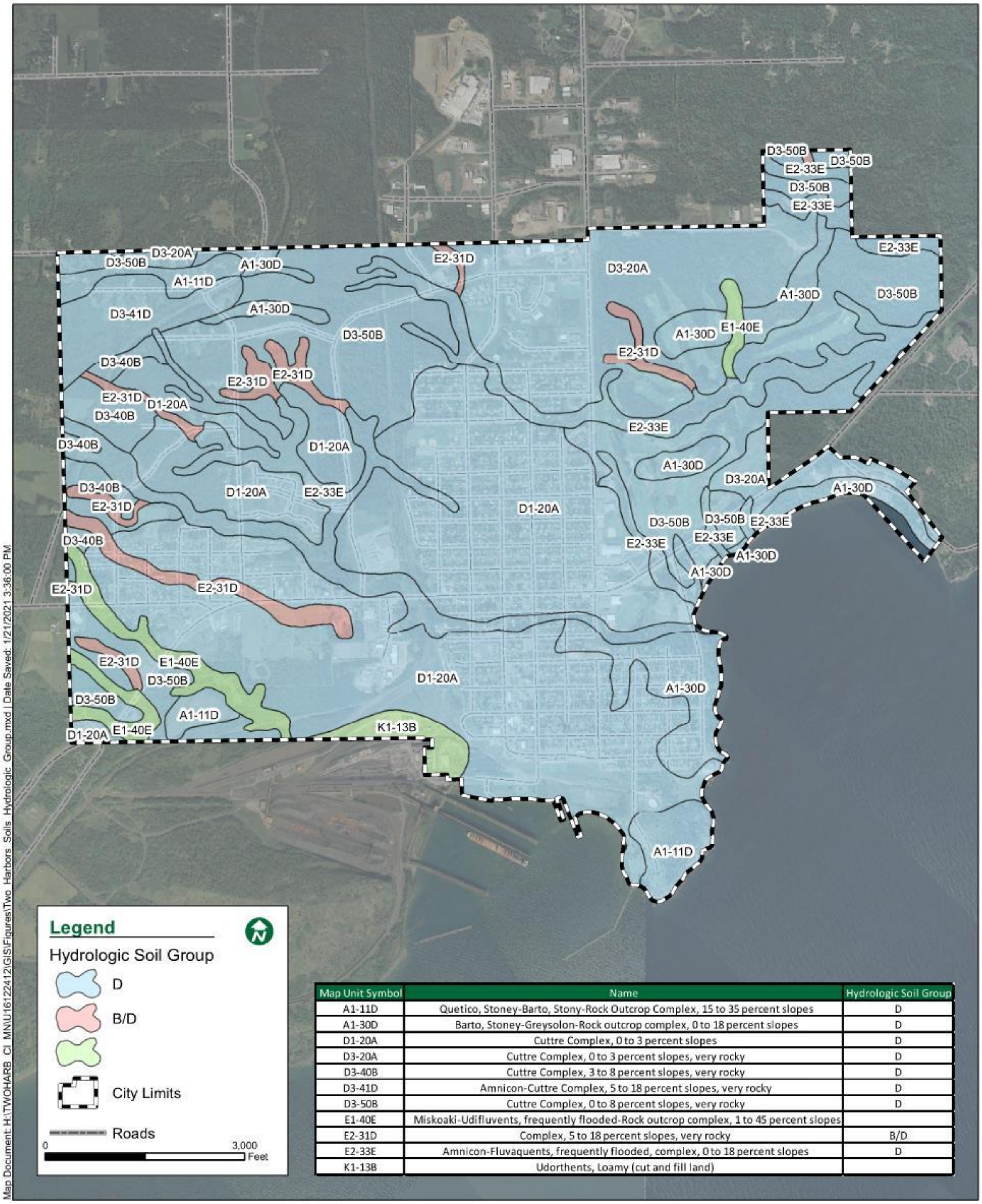
C. Soils

The soils information in this section is taken from the United States Department of Agriculture Natural Resources Conservation Service (NRCS) Soil Survey of Lake County. The soils maps in the report are general and intended for broad planning purposes. The soils of Two Harbors are shown in Error! Reference source not found.. Soil Types within the City consist primarily of Cuttre Complex, 0 to 3 percent slopes (37%) and Cuttre Complex, 0 to 8 percent slopes, very rocky (18%).

The drainage nature of the soils is important for determining the surface water runoff from a given area. If the soil is well drained, a significant portion of the precipitation will be infiltrated into the ground, whereas if a soil is very poorly drained, most of the precipitation will flow from the site of impact.

The Hydrologic Soil Group (HSG) defines a soil's propensity to generate runoff for a given rainfall event. Four HGS groups area identified: A, B, C, D, HSG A soils have the lowest potential to generate runoff and typically consist of sandy and gravely soils. HSG D soils have the highest potential to generate runoff and typically consist of muck, peaty muck, and tight clay soils. The associations found within Two Harbors study area primarily fall into HSG D, indicating a high to very high potential to generate runoff.

Hydric soils are those characteristic soils found in wetland areas. A wetland must possess three technical criteria in order for it to be identified as a wetland. These three are: 1) hydrophytic vegetation, 2) hydric soils, and 3) wetland hydrology. The definition of a hydric soil is: "a soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part."



Map Unit Symbol	Name	Hydrologic Soil Group
A1-11D	Quetico, Stoney-Barto, Stony-Rock Outcrop Complex, 15 to 35 percent slopes	D
A1-30D	Barto, Stoney-Greysolon-Rock outcrop complex, 0 to 18 percent slopes	D
D1-20A	Cuttre Complex, 0 to 3 percent slopes	D
D3-20A	Cuttre Complex, 0 to 3 percent slopes, very rocky	D
D3-40B	Cuttre Complex, 3 to 8 percent slopes, very rocky	D
D3-41D	Amnicon-Cuttre Complex, 5 to 18 percent slopes, very rocky	D
D3-50B	Cuttre Complex, 0 to 8 percent slopes, very rocky	D
E1-40E	Miskoaki-Udifluvents, frequently flooded-Rock outcrop complex, 1 to 45 percent slopes	
E2-31D	Complex, 5 to 18 percent slopes, very rocky	B/D
E2-33E	Amnicon-Fluvaquents, frequently flooded, complex, 0 to 18 percent slopes	D
K1-13B	Udorthents, Loamy (cut and fill land)	

Figure 4: Soils Maps

D. Wetlands

The wetland information in this section is taken from the National Wetland Inventory (NWI). Two Harbors is limited in the number of wetlands present on the NWI within City limits. This is likely due to the resolution of the NWI maps. Instead, the city is characterized by poorly drained soils, smaller depression storage areas, and steep slopes that direct runoff to nearby creeks and lakes. The poorly drained soils trap water in smaller depressions that wouldn't otherwise show up on the NWI mapping. Therefore, the NWI is not a comprehensive view of the city's wetland systems. During preliminary design, it would be prudent to conduct a cursory review of potential wetlands and ensure wetland delineations are conducted prior to final design.

The Minnesota Department of Natural Resources identifies the different wetland types as Lakes, ponds, stormwater ponds, Freshwater Emergent Wetland, and freshwater shrub wetland. Most of the wetlands are classified as stormwater ponds located on the Lakeview National Golf Course, Hidden Springs development, Harbor Hills development and Super one Foods. Error! Reference source not found. illustrates the NWI wetlands that are present within Two Harbors.

E. Stormwater Runoff and Hydraulic Modeling

Stormwater runoff is defined as the portion of precipitation which flows over the ground surface during, and for a short time after, a storm. The quantity of runoff is dependent on the following:

- Rainfall depth and intensity of the storm event
- Amount of antecedent rainfall
- Length of the storm
- Type of surface upon which the rain falls (i.e. soils, land cover, impervious surfaces)
- Slope of the ground surface

The national Oceanic and Atmospheric Administration (NOAA) has been studying trends in the rainfall data to develop statistical hypothetical rainfall event. The most recent study, called ATLAS 14, provides precipitation frequency estimates for most of the Midwest, including Minnesota. Over the last few decades, records and projected trends have indicated that we will see higher intensity rainfall events. Climate change has rapidly affected weather patterns, resulting in shorter duration, higher intensity storms represented by ATLAS 14.

Atlas 14		
Recurrence Interval (Years)	Duration (Hours)	Rainfall (Inches)
1-yr	24	2.30
2-yr	24	2.68
5-yr	24	3.36
10-yr	24	3.96
100-yr	24	6.32

Source: NOAA's National Weather Service (PFDS)

Table 1: Atlas 14 Design Storms

Autodesk's Storm and Sanitary Analysis (SSA) software was utilized to create a regional model of the City, incorporating Atlas 14 rainfall depths and MSE 3 rainfall distributions which simulates a more intense rainfall during the design storm. The increase in rainfall depth and intensity consequently increase runoff rates and volumes within the city's trunk storm sewer system.

The main concerns regarding the aging storm sewer infrastructure of the Two Harbors include conveyance capacity, pipe and structure degradation, inflow and infiltration, and illicit sanitary sewer connections including the original construction of combined sewers.

The water quality removal efficiency for the proposed BMP's (Best Management Practices) where calculated using a variety of water quality software based on the specific need, including the Sizing of Hydrodynamic Separators and Manholes (SHASM), and Minimal Impact Design Standards (MIDS).

Figure 5: NWI Wetlands Map

IV. Stormwater Management Planning and Water Quality Improvements

A variety of stormwater best management practices (BMPs) have been identified based on the location and proximity to critical surface water resources. The following options include maintenance of current stormwater infrastructure, construction of structural practices in conjunction with anticipated County and City capital improvement projects, and new BMPs at critical discharge points near Agate Bay.

A. Hydrodynamic Separator and Debris Separating Baffle Box

One of the goals of the stormwater management plan was to evaluate ways to improve the water quality of Skunk Creek, which currently has an EPA-approved impairment for Escherichia Coli and Turbidity. One way to accomplish this is to treat the storm water runoff before it drains to the Creek.

The urban reach of Skunk Creek receives stormwater runoff from a 200-acre residential area. The runoff carries with it pollutants such as sediment, oils, trash, and yard waste. These pollutants can contain phosphorus and nitrogen that are harmful to lake and river systems. The stormwater runoff from the area is collected in the City's storm sewer system and discharges into Skunk Creek at 6 locations. The point sources created by these 6 outlets provide a unique opportunity to treat the stormwater runoff before discharging into Skunk Creek.

There are multiple challenges associated with treating the stormwater runoff at these locations:

- Limited space due to the area already being developed.
- The volume and rate of stormwater passing through these locations are high due to the large watershed areas.
- High costs for construction and roadway replacement when not connected to a linear capital improvement project (CIP).

Due to the spatial constraints, Hydrodynamic Separators (HDS) and Debris Separating Baffle Boxes (DSBB) would provide a great solution to treating the stormwater. HDS and DSBB structures are installed below the street level and are designed to remove total suspended solids (TSS), capture free floating oils and trash, and some include an internal high flow bypass. Maintenance is easily performed for both structures using a vacuum truck.

Additionally, these structures can easily be incorporated with upcoming City or County Capital Improvement Projects. Refer to Error! Reference source not found. for the locations of upcoming City and County linear CIP locations.

1. Hydrodynamic Separators

A hydrodynamic separator (HDS) provides a minimally invasive solution by replacing an existing manhole with a proprietary mechanical structure often utilizing a system of weirs, orifices, swirl mechanisms, sumps, skimmers to remove grit, free floating oil, gross solids, and suspended sediment. One example is the SciCLONE Separator by BioClean, many others exist on the market. The total suspended sediment (TSS) removal efficiency of the SciCLONE Separator was analyzed using the Sizing Hydrodynamic Separators and Manholes (SHASM) software. The results show that as the incoming flowrate increases, the structure size must also increase to maintain the same level of removal efficiency. The most cost-effective solution is to install the SciCLONE Separator in drainage areas less than 6 acres. The drainage areas of the proposed locations vary in size between 3.3 – 5.6 acres, corresponding to an annual total suspended sediment load of 5121 - 8685 lbs.

The removal efficiency of the SciCLONE Separator varies based on the particle size distribution used in the removal efficiency calculation. To better understand the performance potential of the SciCLONE separator, both the MNDOT Road Sand distribution and Nationwide Urban Runoff Program (NURP) distribution were analyzed. The MNDOT Road Sand distribution contains a higher amount of course sand particles ranging in size from 100-180 Microns. This particle distribution would commonly be used for gritting the roads during winter weather. The SciCLONE Separators would be effective in removing 88 - 100% of the total load resulting from a MNDOT Road Sand particle distribution. The NURP distribution was developed using settling velocity measurements from 46 different samples from 13 unique sites[1]. The distribution contains a much wider range of particle sizes, ranging from 1 to 900 microns in size. The larger percentage of fine particles means that the HDS will not be as effective due to the slower settling velocities. The SciCLONE Separators would be effective in removing 10 – 26% of the total load resulting from the NURP particle distribution.

The City and County have designed a joint project along County State Aid Highways (CSAH) 20, 30 and 35 as well as City streets along 4th, 5th, and 6th Avenues. This project included design and bid alternatives for two BioClean SciCLONE structures located at the intersections of 5th Avenue and 4th Avenue with CSAH 30 (8th Street). The structures are both SC-5 (5' diameter) SciCLONEs. The structures were quoted at $9,700 per structure, delivered to the site. Installation costs should be determined by the contractor upon project bidding. The bid opening with alternate is scheduled for April 6, 2021. The project will be awarded by Two Harbors City Council on April 27th, 2021.

The proposed locations and corresponding drainage areas associated with each location are illustrated in Error! Reference source not found.. An example of the typical sediment loading and removal efficiencies of the SciClone Separator for a proposed location can be seen in **Table 2.**

SciCLONE: 7 TSS Removal						
Name	Drainage Area (Acres)	Total Load / Year (lbs)	MNDOT Road Sand Distribution Removal Efficiency (%)	NURP Distribution Removal Efficiency (%)	Model Height (ft)	Model Diameter (ft)
SciClone	4.8	607	91.8	11	5	4
SciClone	4.8	607	95.7	13.1	6	5
SciClone	4.8	607	97.8	14.9	7	6
SciClone	4.8	607	98.9	16.6	8	7
SciClone	4.8	607	99.5	18.3	9	8
SciClone	4.8	607	99.7	19.8	10	9
SciClone	4.8	607	99.9	21.2	11	10
SciClone	4.8	607	99.9	22.6	12	11
SciClone	4.8	607	100	23.9	13	12

Table 2: HDS Removal Efficiency

[1] U.S. Environmental Protection Agency. (1986). *Methods from analysis of Detention Basins for Control of Urban Runoff Quality* (EPA440/5-81-001. Nonpoint Source Branch. Washington, D.C.: Driscoll, E.

SciCLONE Cost Benefit				
Name	Drainage Area (Acres)	TSS Load Removed / Year (lbs)	Cost ($)	Cost / Pound TSS Removed (Year 1)
SciClone	4.75	582	$ 35,100	$ 60.35

Table 3: HDS Cost Benefit

2. Debris Separating Baffle Box (DSBB)

A Debris Separating Baffle Box is a great solution to capture TSS, free floating oils, and trash in storm sewer with large drainage areas. The most cost-effective solution is to install the DSBB in drainage areas larger than 6 acres. The outlets into Skunk Creek are ideal locations to install DSBB units in order to capture as many pollutants as possible before they reach Skunk Creek. The DSBB is installed in line with the existing storm sewer and incorporates a high flow bypass system. Although the DSBB is larger in size compared to other HDS structures it is still installed below the street level. The drainage areas of the proposed locations vary in size between 17 – 46 acres, corresponding to an annual total suspended sediment load of 3010 - 5940 lbs. The Debris Separating Baffle Box would be effective in removing approximately 80% of the TSS load. The proposed locations and corresponding drainage areas associated with each location are illustrated in Error! Reference source not found.. Typical sediment loading and removal efficiencies of the DSBB for the proposed locations can be seen in **Table 4**. Anticipated costs and benefit are described in **Table 5**.

DSBB: TSS Removal				
Name	Drainage Area (Acres)	Model	Total Load / Year (lbs)	Removal Efficiency (%)
DSBB	40.4	7 x 14	5234	80

Table 4: DSBB Removal Efficiency

DSBB Cost Benefit				
Name	Drainage Area (Acres)	TSS Load Removed / Year (lbs)	Cost ($)	Cost / Pound TSS Removed (Year 1)
DSBB	40.4	4187	$ 93,200	$ 22.26

Table 5: DSBB Cost Benefit

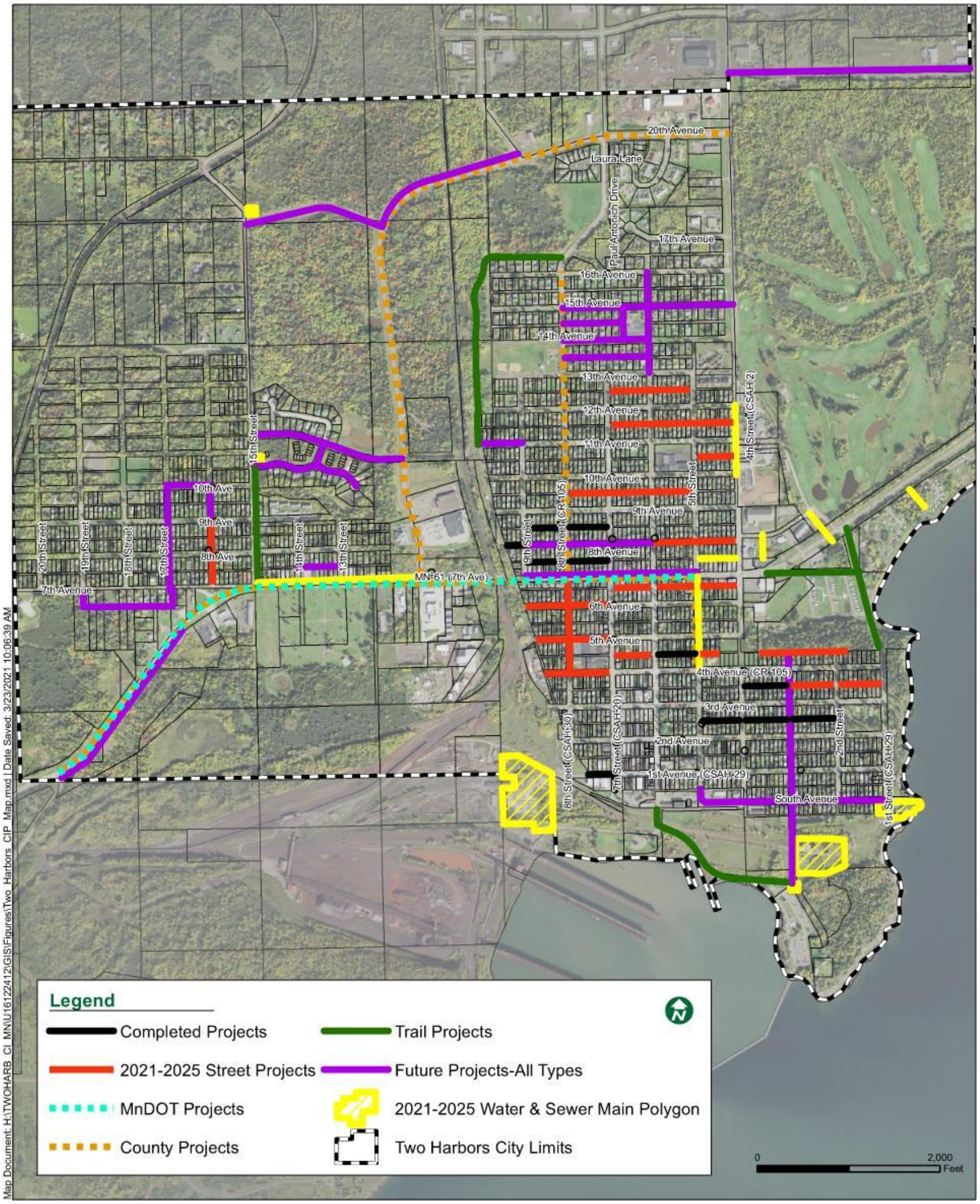


Figure 6: City and Council CIP Locations

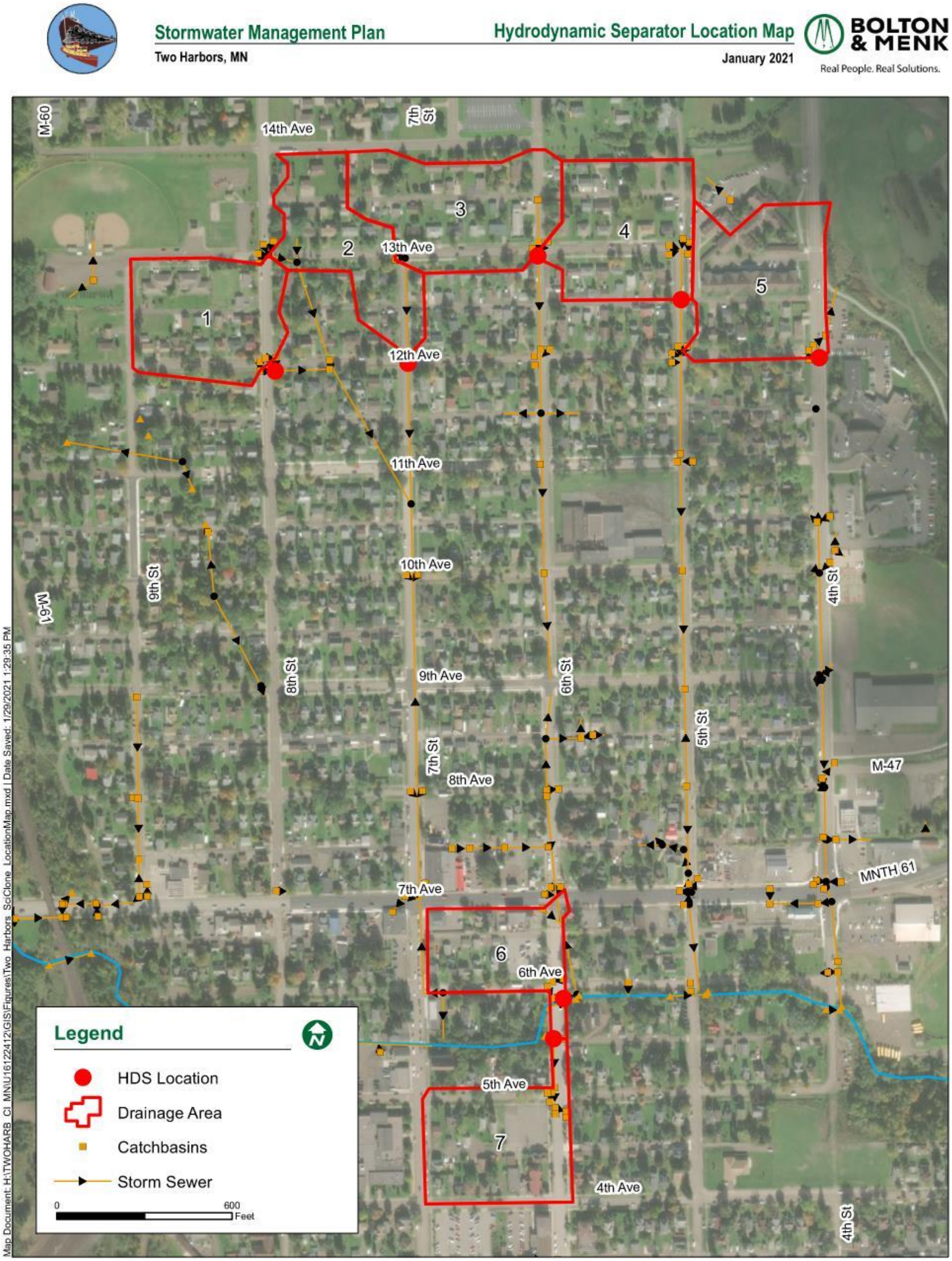


Figure 7: HDS Locations

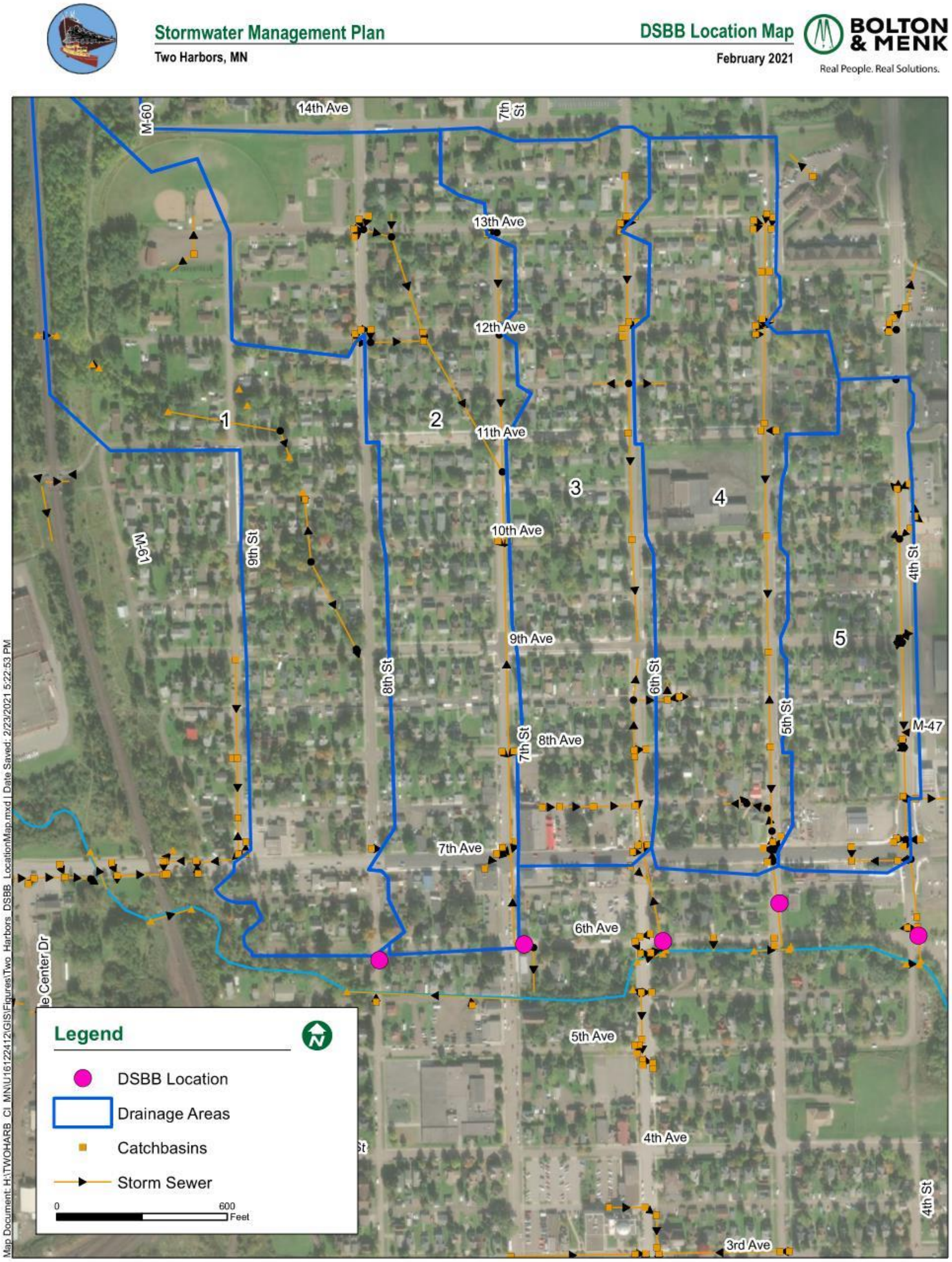


Figure 8: DSBB Locations

B. Agate Bay Biochar - Enhanced Filtration Basins & Sedimentation Basins

The University of Minnesota Duluth has been working with the City of Two Harbors and Lake County SWCD to help identify the sources of E. Coli found in Agate Bay. Previous studies have identified potential fecal sources as livestock, wildlife, pets, and non-compliant septic systems. Additional research is needed to identify potential sources from illicit storm sewer connections and inflow and infiltration (I/I).

The University of Minnesota Duluth (UMD) is experienced in studying the benefits of using biochar for biological management of stormwater runoff. Through the collaboration of the City of Two Harbors, University of Minnesota Duluth, and The Minnesota Department of Natural Resources (MnDNR), the City has a unique opportunity to implement biochar – enhanced sand filtration basins (biochar filtration basins) between downtown Two Harbors and Agate Bay.

The potential sources of E. Coli described above are transported by stormwater runoff and collected by the City's storm sewer. Storm sewer south of 4th Avenue route the drainage directly into Agate Bay, discharging at multiple locations. The green space between downtown Two Harbors and Agate Bay, currently owned by the City of Two Harbors and the MnDNR, provides the perfect opportunity to intercept the storm sewer from downtown Two Harbors and route it into biochar filtration basins for treatment before discharging into Agate Bay. The biochar filtration basins would be effective in capturing total suspended solids (TSS), total phosphorus (TP) and treating biological hazards associated with E. Coli.

1. Design Considerations

The following design considerations were used to quantify the appropriate basin footprint, materials required, and estimated construction costs. These design considerations were developed in conjunction with University of Minnesota Duluth researchers and may not be comprehensive. All design considerations and construction details will be verified during final design.

a) UMD described basins to be sized to 2-5% of the catchment area and a high flow bypass is incorporated to preserve the functionality during large rainfall events. For much larger contributing drainage areas, the basin footprint is likely closer to 2% of the total drainage area to reduce construction costs.

b) Coon Creek Watershed District (CCWD) has identified a smaller footprint. For this project, it is assumed that pretreatment of sediment is a critical component and can result in a smaller footprint biochar filter. It is assumed that only the base flow, or first flush, rainfall event will be treated by the biochar filter.

c) Biochar basins are composed of a homogenous mixture of sand and biochar, combined in a 2:1 ratio, respectively.

d) The biochar mix is generally 2 feet in depth and is covered with a 6-inch layer of sand and compost.

e) The upper layer allows vegetation to be present and can further contribute to the removal of harmful pollutants.

f) A level spreader is used to equally saturate the biochar mixture and drain tile is used to collect the filtered stormwater.

g) The basin and outlet control structure could be sized to accommodate the inflow volume from a 5-year to 10-year return interval storm event. All larger events should be bypassed.

h) The E. Coli removal efficiency is not implicitly quantified but can be correlated to sediment loading. Therefore, cost estimates are normalized per pound TSS removed to better understand benefit. Additional monitoring opportunities should be considered to track long term performance.

There are presently 6 storm sewer outlets that discharge into Agate Bay. Each outlet and its corresponding drainage area were analyzed for a biochar filtration basin and/or sedimentation basin. The drainage areas and proposed basin locations are described below. Refer to Error! Reference source not found. for the respective drainage areas and basin locations. Refer to Error! Reference source not found. for the City Parcel information.

2. Bioretention Basin 1 – Area 1

The drainage area for Basin 1, located on the west side of downtown Two Harbors, is comprised of 31 acres of primarily open space and residential lots. Stormwater runoff flows overland from northwest to southeast, discharging into Agate Bay. Drainage patterns in area 1 are not well defined making this area more difficult to collect and manage the stormwater runoff in one location. For that reason, additional data collection and infrastructure may be required to capture the stormwater runoff for treatment in a bioretention basin. **Table 6** describes the bioretention basin design requirements to treat drainage area 1. **Table 7** describes the anticipated construction costs and benefit.

Bioretention Basin - Area 1: Sizing		
Drainage Area (Acres)	1" Water Quality Volume (CF)	Pretreatment Volume [20% of Water Quality Volume] (CF)
31.1	2290	460

Table 6: Bioretention Basin - Area 1: Sizing

Bioretention Basin - 1: Pollutant Removal			
TSS Load (lbs)	TSS Load Removed (lbs)	Cost ($)	Cost / Pound TSS Removed ($)
3817	3245	$ 56,720	$ 17

Table 7: Bioretention Basin – Area 1: Pollutant Removal

Bioretention Basin 1					
February, 2021					
No.	Item	Units	Approx. Qty	Estimated Unit Price	Estimated Total Price
	BASE BID:				
1	MOBILIZATION	LS	1	$4,000	$4,000
2	COMMON EXCAVATION	CY	210	$16	$3,360
3	COURSE FILTER AGGREGATE	CY	80	$55	$4,388
4	FILTER TOPSOIL BORROW	CY	170	$50	$8,500
5	INLET STRUCTURE	LS	1	$6,000	$6,000
6	OUTLET STRUCTURE	LS	1	$6,000	$6,000
7	UNDERDRAIN	LS	1	$8,000	$6,000
8	EROSION CONTROL MEASURES	LS	1	$3,000	$3,000
9	SEEDING, FERTILIZER, AND EROSION CONTROL BLANKET	SY	300	$8	$2,400
TOTAL ESTIMATED CONSTRUCTION COSTS					**$43,600**
PROJECT CONTINGENCY (10%)					**$4,400**
PROJECT OVERHEAD (20%)					**$8,720**
TOTAL ESTIMATED PROJECT COSTS					**$56,720**

Table 8: Bioretention Basin - 1: Cost Estimate

3. Regional Biochar – Enhanced Sand Filtration Basin (Drainage Areas 2, 3, 4, 5)

Drainage Area 2 includes roughly 42 acres of downtown Two Harbors. The land use is composed primarily of commercial buildings with isolated residential lots. Stormwater runoff is collected by catch basins and routed through the storm sewer before discharging directly into Agate Bay.

Drainage Areas 3,4, and 5 include 53.5 acres of downtown Two Harbors. The urban land use includes primarily residential housing. Stormwater runoff is collected by catch basins and routed through the storm sewer before discharging at each of their respective locations. Drainage areas 3 and 4 discharge into an open ditch that routes the stormwater into Agate Bay. Drainage area 5 discharges directly into Agate Bay.

<u>Regional Treatment Approach</u>

Drainage areas 2, 3, 4, and 5 follow similar drainage patterns, allowing for the opportunity to collect the stormwater runoff from all 4 drainage areas in one location. Drainage area 2 would require a diversion into the ditch that is responsible for collecting and routing stormwater runoff from drainage areas 3 and 4. The diversion would require a stormwater pretreatment feature before connecting to the existing ditch.

The existing ditch is likely classified as a wetland due to the nature of the soils that are present. The ditch provides a great opportunity to enhance its ecological benefit as a wetland by converting it into a 2-stage ditch. The 2 stages would include a 10’ wide low flow channel with 10’ wide benches on either side that would aid in conveying stormwater runoff during larger rainfall events. The ecological benefits could be improved further by converting the benches into biochar- enhanced sand filters. The cost estimate for the 2-stage ditch and the option to enhance the benches are shown in Table 9.

Drainage area 5 would also require a diversion from its current storm sewer alignment. The storm sewer from area 5 would be rerouted and combined with the stormwater runoff from areas 2,3, and 4. The stormwater runoff from all 4 areas would be pretreated by a bioretention sump basin located adjacent to the drainage ditch in preparation for the biochar filtration basin. Refer to Figure 9 for the general layout of the biochar – enhanced sand filtration basins.

Two Stage Ditch					
February, 2021					
No.	Item	Units	Approx. Qty	Estimated Unit Price	Estimated Total Price
	BASE BID:				
1	MOBILIZATION	LS	1	$25,000	$25,000
2	CLEARING	AC	1.7	$3,000.00	$5,165
3	GRUBBING	AC	0.5	$2,000.00	$1,000
4	COMMON EXCAVATION - ONSITE (EV) (P)	CY	2200	$16.06	$35,332
5	COMMON EXCAVATION - OFFSITE (EV) (P)	CY	1100	$49.95	$54,945
6	SALVAGE AND RESPREAD TOPSOIL	SY	1333	$14.98	$19,973
7	SILT FENCE MS - MAINTAINED	LF	800	$3.11	$2,488
8	COIR EROSION CONTROL MAT	SY	500	$8.80	$4,400
9	MNDOT SEED MIXTURE 34-261	LB	100	$100.00	$10,000
10	SEEDING	ACRE	1.7	$4,176.20	$7,100
11	PEA ROCK (COURSE FILTER AGGREGATE) (CV) (P)	CY	10	$160.00	$1,600
12	COMMON EXCAVATION FOR TRAIL - OFFSITE (EV) (P)	CY	20	$40.24	$805
13	DITCH CHECKS	EA	10	$1200.00	$12,000
14	36" RCP	LF	110	$100.00	$11,000
15	12" RCP	LF	50	$70.00	$3,500
16	CONNECT TO EX. STM SEWER	EA	1	$2500.00	$2,500
17	TREES AND SHRUBS	EA	300	$20.00	$6,000
TOTAL ESTIMATED CONSTRUCTION COSTS					**$202,800**
PROJECT CONTINGENCY (10%)					**$20,300**
PROJECT OVERHEAD (20%)					**$40,560**
TOTAL ESTIMATED PROJECT COSTS					**$263,660**
18	COARSE FILTER AGGREGATE (CV) (P)	CY	1200	$76.60	$91,920
19	BIOCHAR FILTER MEDIA	CY	360	$329.18	$118,505
20	SAMPLE PORTS	EA	2	$1,439.37	$2,879
21	4' DIAMETER STORM SEWER OUTLET CONTROL STRUCTURE	EA	2	$6,741.93	$13,484
22	HYDRODYNAMIC SEPARATOR	EA	1	$15650.00	$15,650
23	4" DRAINTILE	LF	400	$13.50	$5,400
TOTAL ESTIMATED CONSTRUCTION COSTS					**$450,600**
PROJECT CONTINGENCY (10%)					**$45,100**
PROJECT OVERHEAD (20%)					**$90,120**
TOTAL ESTIMATED PROJECT COSTS W/ BIOCHAR ENHANCED FILTER BENCHES					**$585,820**

Table 9: Two Stage Ditch - Cost Estimate

BIOCHAR - ENHANCED SAND FILTER					
February, 2021					
No.	**Item**	**Units**	**Approx. Qty**	**Estimated Unit Price**	**Estimated Total Price**
	BASE BID:				
1	MOBILIZATION	LS	1	$45,405	$45,405
2	CLEARING	AC	0.2	$6,220	$1,244
3	GRUBBING	AC	0.2	$4,391	$878
4	COMMON EXCAVATION - ONSITE (EV) (P)	CY	1100	$16	$17,666
5	COMMON EXCAVATION - OFFSITE (EV) (P)	CY	1100	$50	$54,945
6	SALVAGE AND RESPREAD TOPSOIL	SY	150	$15	$2,247
7	INLET PROTECTION - MAINTAINED	EA	2	$268	$537
8	SILT FENCE MS - MAINTAINED	LF	350	$3	$1,089
9	COIR EROSION CONTROL MAT	SY	150	$9	$1,320
10	COARSE FILTER AGGREGATE (CV) (P)	CY	200	$77	$15,320
11	BIOCHAR FILTER MEDIA	CY	60	$329	$19,751
12	6" SLOTTED PVC SCH 40 DRAINTILE PIPE	LF	300	$20	$6,078
13	CLEANOUT W/ VENTED SCREEN	EA	2	$514	$1,028
14	SAMPLE PORTS	EA	2	$1,439	$2,879
15	4' DIAMETER STORM SEWER OUTLET CONTROL	EA	1	$6,742	$6,742
16	MNDOT SEED MIXTURE 34-261	LB	5	$46	$230
17	PEA ROCK (COURSE FILTER AGGREGATE) (CV) (P)	CY	10	$113	$1,134
18	COMMON EXCAVATION FOR TRAIL - OFFSITE (EV) (P)	CY	20	$40	$805
19	GRAVEL AGGREGATE BASE FOR TRAIL (CV) (P)	CY	10	$68	$684
TOTAL ESTIMATED CONSTRUCTION COSTS					**$180,000**
PROJECT CONTINGENCY (10%)					**$18,000**
PROJECT OVERHEAD (20%)					**$36,000**
TOTAL ESTIMATED PROJECT COSTS					**$234,000**

Table 10: Biochar - Enhanced Sand Filter - Cost Estimate

4. Drainage Area 6:

Drainage Area 6 is comprised of the parking lot for the Two Harbors lighthouse and the adjacent wood land. There are presently 3 small basins that collect the runoff from the lighthouse parking lot. The three basins are connected in series and discharge directly into Agate Bay. This configuration provides a great opportunity to retrofit the furthest most downstream basin into a biochar filtration basin. The retrofit would be contained to the same footprint as the existing basin, requiring minimal disturbance to the landscape. The two upstream basins would provide adequate pretreatment for the stormwater runoff before passing through the biochar filtration basin. The following describes the biochar filtration basin design requirements to treat drainage area 6.

Biochar Filtration Basin - 6: Sizing		
Drainage Area (Acres)	Basin Footprint [Existing footprint] (SF)	Pretreatment Footprint [Existing Upstream Basins] (SF)
3.1	5030	5330

Table 1: Biochar Filtration Basin - Area 6: Sizing

Biochar Filtration Basin - 6: Pollutant Removal			
TSS Load (lbs)	TSS Load Removed (lbs)	Cost ($)	Cost / Pound TSS Removed ($)
591	502	$ 105,300	$ 210

Table 12: Biochar Filtration Basin – Area 6: Pollutant Removal

Biochar - Enhanced Sand Filter - Basin 6					
February, 2021					
No.	**Item**	**Units**	**Approx. Qty**	**Estimated Unit Price**	**Estimated Total Price**
	BASE BID:				
1	MOBILIZATION	LS	1	$7,700	$7,700
2	TRAFFIC CONTROL	LS	1	$1,500	$1,500
3	COMMON EXCAVATION	CY	470	$16	$7,520
4	SELECT GRANULAR BORROW	CY	250	$36	$9,000
5	BIOCHAR	CY	130	$250	$32,500
6	FILTER TOPSOIL BORROW	CY	90	$50	$4,500
8	OUTLET STRUCTURE	LS	1	$7,000	$7,000
	UNDERDRAIN	LS	1	$8,000	$8,000
9	EROSION CONTROL MEASURES	LS	1	$3,000	$3,000
10	FINAL SEEDING, FERTILIZER, AND EROSION CONTROL BLANKET	SY	100	$2.43	$243
TOTAL ESTIMATED CONSTRUCTION COSTS					**$81,000**
PROJECT CONTINGENCY (10%)					**$8,100**
PROJECT OVERHEAD (20%)					**$16,200**
TOTAL ESTIMATED PROJECT COSTS					**$105,300**

Table 2: Biochar - Enhanced Sand Filtration Basin - Area 6

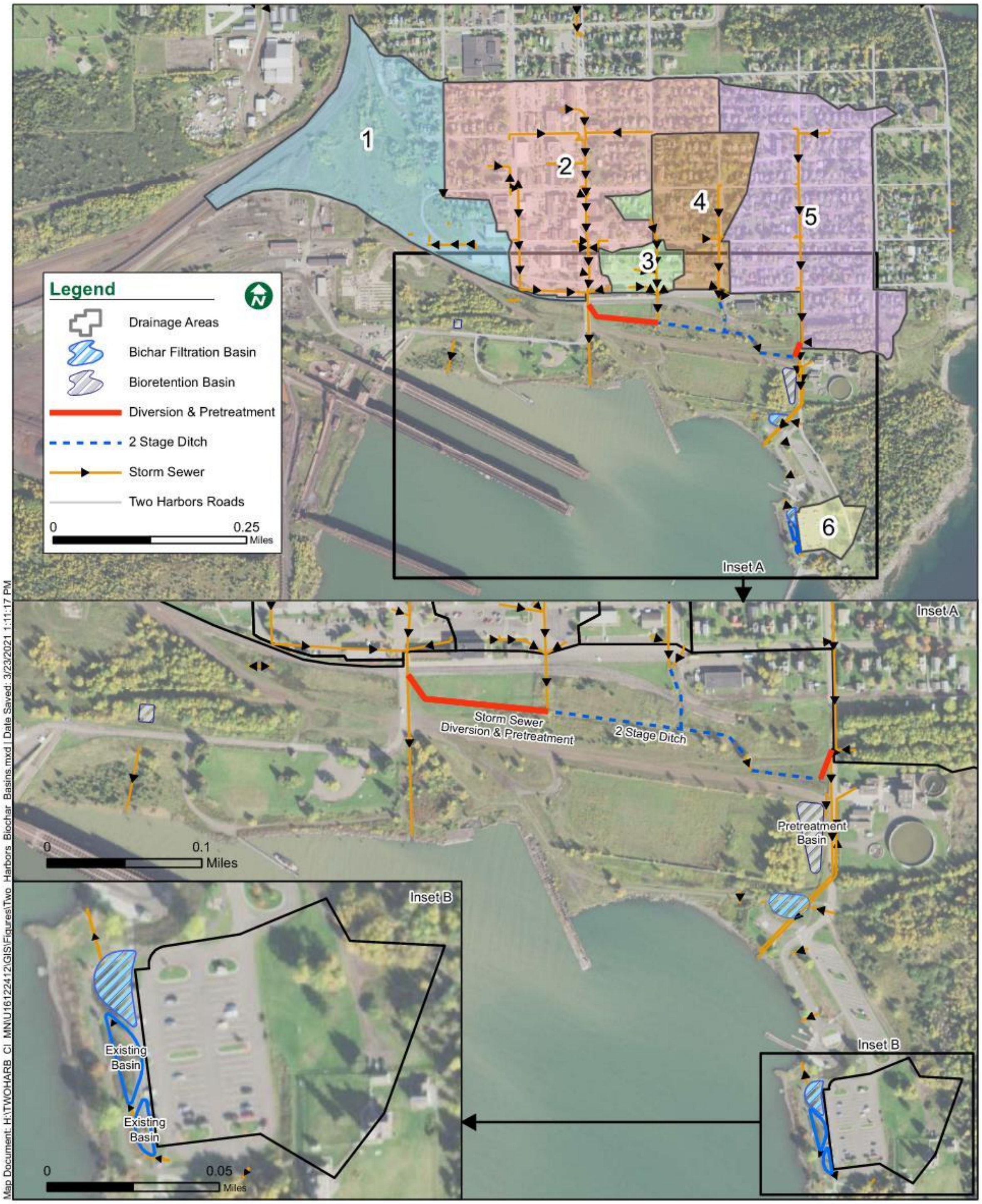


Figure 9: Biochar - Enhanced Sand Filtration Basins and Bioretention Basins Location Map

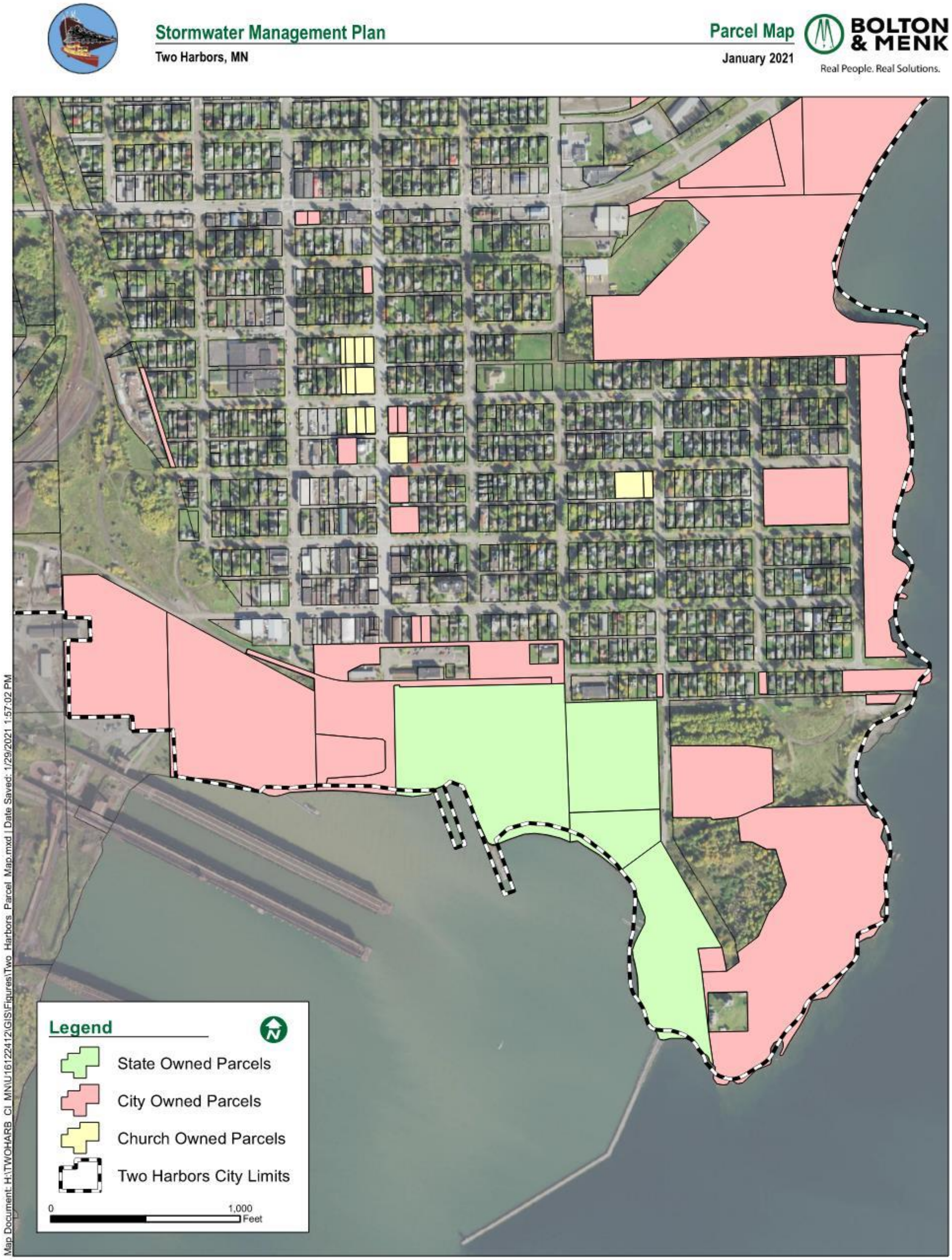


Figure 10: Parcel Map

5. Stormwater Basin Restoration

The Cemetery stormwater basin was constructed in 2004 south of the cemetery after recommendations made in the 2001 Stormwater Management plan. The basin provides attenuation and water quality treatment for the watershed draining to Segog Creek. The Creek passes through the stormwater basin before making its way into Agate Bay. The basin was constructed as part of a project to redirect Segog Creek back to its original drainage route. The Creek was temporarily routed into Skunk Creek during a Highway 61 street project and was never routed back to its original drainage path until the 2004 project was completed.

The basin was constructed with a pretreatment forebay and a detention area to promote infiltration. Visual Inspection has shown slow infiltration, indicating the filtration media is clogged from sediment accumulation. Over the last 17 years the pretreatment forebay and detention areas have accumulated sediment as a result of stormwater runoff and erosion around the inlet. The clogging of the filtration media has a direct negative effect on the basins ability to treat pollutants from stormwater runoff.

Infiltration basins and wet ponds are intended to provide water quality treatment to the stormwater runoff. Typical pollutant removal rates for wet ponds are reductions of 60% to 90% of total suspended solids (TSS) and 34% to 60% of total phosphorus (TP).[2] The permanent pool volume and associated "…retention time, (the length of time a given volume of runoff is retained in a pond) is critical to its removal efficiency."[3] A reduction of permanent pool volume is directly related to a reduction in retention time and similarly related to the pollutant removal rate for the pond. Wet ponds are typically recommended to be cleaned and maintained if sediment accumulates to 50% of the permanent pool volume.

Corrective maintenance involves removing the accumulated sediment and restoring the hydraulic conductivity of the filtration media. Additional stabilization and armoring should be installed around the inlet and outlet to prevent further erosion.

The MPCA requires testing for polycyclic aromatic hydrocarbons (PAHs), specific metals and other pollutants to determine the level of contamination. Professional Service Industries, Inc. (PSI) was hired to sample the highest priority ponds (top 8 only) to determine the level of contamination. The MPCA's document "Managing Stormwater Sediment Best Management Practices Guidance" (May, 2017) and "Managing Dredge Materials" (April, 2014) discusses sampling requirements and sediment disposal requirements based on the level of contamination. The MPCA defines the dredge material Management Levels based on Soil Reference Values (SRV) that characterize the material as hazardous waste based on concentrations of a number of metals and chemicals. The Management Levels are defined as follows.

- **Management Level 1:** Suitable for use or reuse on residential or recreational properties. Material is at or below the concentration limits all of the Tier 1 SRVs.
- **Management Level 2:** Suitable for use or reuse on properties with industrial use. Material is at or below the concentration limits for the Tier 2 SRVs.
- **Management Level 3:** Not suitable for use or reuse and must be landfilled.

[2]Erickson, A.J.; Taguchi, V.J.; Gulliver, J.S. The Challenge of Maintaining Stormwater Control Measures: A Synthesis of Recent Research and Practitioner Experience. *Sustainability* **2018**, *10*, 3666. https://www.mdpi.com/2071-1050/10/10/3666
[3]https://stormwater.pca.state.mn.us/index.php?title=Stormwater_wet_pond_fact_sheet accessed August 2019

Material has significant contamination and has one or more concentrations exceeding the limits for the Level 2 SRV.

Sediment disposal costs are related to the Management Level. Other cost considerations include time of year for construction, site access, dewatering, sediment excavation methods (i.e. mechanical or hydraulic methods) and site restoration. Preliminary Engineer's Estimates were developed for the cemetery pond. Table 18 summarizes the estimated costs to clean the pond. The following assumptions were included in the estimate.

- SRV Level II and SRV Level III ponds assume landfill disposal costs.
- All excavation will be mechanical methods. Estimates should be modified if the City requires an alternate method.
- Mobilization, traffic control, pond dewatering, erosion control methods and street sweeping were assumed lump sum.
- Site restoration was assumed at all access locations and should be considered approximate.
- This project will also include restoration of inlet and outfall erosion issues, and channel armoring.

Cemetery Pond					
February, 2021					
No.	Item	Units	Approx. Qty	Estimated Unit Price	Estimated Total Price
	BASE BID:				
1	MOBILIZATION	LS	1	$6,000	$6,000
2	TRAFFIC CONTROL	LS	1	$1,500	$1,500
3	POND DEWATERING	LS	1	$26,500	$26,500
4	INLET MAINTENANCE	LS	1	$2,500	$2,500
5	MUCK EXCAVATION (EV) - MANAGEMENT LEVEL 1	TONS	1,400	$20	$28,000
6	MUCK EXCAVATION (EV) - MANAGEMENT LEVEL 2	TONS	0	$25	$0
7	MUCK EXCAVATION (EV) - MANAGEMENT LEVEL 3	TONS	0	$40	$0
8	EROSION CONTROL MEASURES	LS	1	$3,000	$3,000
9	MINOR GRADING (OUTLET)	CY	50	$20	$1,000
10	COMMON TOPSOIL BORROW	CY	60	$30	$1,800
11	RANDOM CLAS III RIP RAP (OUTLET)	CY	65	$90	$5,850
12	FINAL SEEDING, FERTILIZER, AND EROSION CONTROL BLANKET	SY	1,800	$2.43	$4,374
TOTAL ESTIMATED CONSTRUCTION COSTS					**$68,500**
PROJECT CONTINGENCY (10%)					**$6,900**
PROJECT OVERHEAD (20%)					**$13,700**
TOTAL ESTIMATED PROJECT COSTS					**$89,100**

Table 14: Cemetery Pond Cost Estimate

6. Stormwater Basin Repair

The Harbor Hills stormwater ponds were constructed in 2003 as part of the Harbor Hills residential development. The ponds provide stormwater management and water quality treatment. Visual inspections revealed separation of the storm sewer aprons. The separation is causing erosion and scour of the surrounding embankment. Corrective maintenance involves reconnecting the separated flared end structure, stabilizing the surrounding embankment, armoring the outlet to prevent scour, and removing the accumulated sediment deposited from the erosion. Preliminary Engineer's Estimates were developed for the outlet repair. **Table 19** summarizes the estimated costs for the outlet repair.

Harbor Hills Outlet Repair					
February, 2021					
No.	Item	Units	Approx. Qty	Estimated Unit Price	Estimated Total Price
	BASE BID:				
1	MOBILIZATION	LS	1	$4,000.00	$4,000.00
2	TRAFFIC CONTROL	LS	1	$1,500.00	$1,500.00
3	MINOR GRADING	CY	40	$20.00	$800.00
5	RANDOM CLASS III RIP RAP	CY	65	$90.00	$5,877.00
6	GEOTEXTILE FABRIC TYPE IV	SY	120	$5.00	$600.00
7	COURSE FILTER AGGREGATE	CY	30	$54.85	$1,646.00
8	COMMON TOPSOIL BORROW	CY	30	$30.00	$900.00
9	EROSION CONTROL MEASURES	LS	1	$3,000.00	$3,000.00
10	SEEDING WITH MNDOT 35-241 SEED MIXUTRE, FERTILZER TYPE 3, AND CATEGORY 3N BLANKET	SY	150	$2.43	$ 365.00
TOTAL ESTIMATED CONSTRUCTION COSTS					**$18,700.00**
PROJECT CONTINGENCY (10%)					**$1,900.00**
PROJECT OVERHEAD (20%)					**$3,740.00**
TOTAL ESTIMATED PROJECT COSTS					**$24,340.00**

Table 15: Harbor Hills Outlet Repair Cost Estimate

7. Streambank Stabilization and Restoration

The City of Two Harbors has entered into an agreement with the U.S. Army Corps of Engineers, Detroit District (USACE) to conduct a stream assessment and evaluation of Skunk Creek that includes sediment and turbidity monitoring as part of the stormwater management plan.

The stream assessment will identify sources and sinks of Skunk Creek from the headwaters to the outlet at Lake Superior. The study will prioritize areas of the stream that are currently experiencing bank erosion. The USACE will collect sediment from the eroding banks and continue to monitor the turbidity in the stream.

The goal of the study is to better understand the current drainage infrastructure, flooding and water quality issues, and provide a set of tools for prioritizing mitigation and improvement projects.

V. Funding Opportunities

The City and Lake SWCD should pursue cooperating project funding. Implementing these types of plans, which are cooperatively constructed, will aide in obtaining grants and outside agency funding. Lake SWCD and the City of Two Harbors have developed successful partnerships and will continue to identify water quality improvement projects that have regional significance. **Table 20** is a summary of available grants. These grants are subject to change and include variations of the following.

- Partnership and submittal requirements.
- Minimum and maximum project costs.
- Available funding and cost share/match requirements.
- Measurable water quality outcomes and project goal requirements.

Name	Summary	Agency	Eligibility
Clean Water Fund Competitive Grant	Protecting, enhancing, and restoring water quality in lakes, rivers, and streams in addition to protecting ground water and drinking water sources from degradation.	Minnesota Board of Water & Soil Resources (BWSR)	County; Watershed District
Clean Water Funding - Conservation Corps	Provides hands-on environmental stewardship and service-learning opportunities to youth and young adults while providing low cost labor to eligible applicants.	Minnesota Board of Water & Soil Resources (BWSR);	City; County
Clean Water Partnership Loan Program	Control of nonpoint source pollution to surface and groundwater.	Minnesota Pollution Control Agency (MPCA)	City; County; State Agency; Tribal; Watershed District
Conservation Partners Legacy Grant Program	To restore, protect or enhance prairies, wetlands, forests, or habitat for fish, game, or wildlife in Minnesota.	Minnesota Department of Natural Resources (MNDNR)	City; County; State Agency; Federal Agency
Environment and Natural Resources Trust	ENRTF aims to protect, conserve, preserve, and enhance Minnesota's air, water, land, fish, wildlife, and other natural resources.	Environment and Natural Resources Trust Fund (ENRTF)	City; County; State Agency; Federal Agency; Tribal
Five Star and Urban Waters Restoration Grant Program	Develop community capacity to sustain local natural resources by improving water quality, watersheds and the species and habitats they support.	National Fish and Wildlife Foundation; Other - Minnesota	City; County; State Agency
One Watershed One Plan - Planning Grants 2020.pdf	Supports partnerships of local governments in developing prioritized, targeted, and measurable implementation plans for planning at the major watershed scale and aligning local plans with state strategies.	Minnesota Board of Water & Soil Resources (BWSR)	City; County; State Agency; Watershed District
Section 319 Small Watersheds Focus Group A	Funding for projects to reduce nonpoint source pollution in lakes, rivers, and streams in areas with approved plans.	Minnesota Pollution Control Agency (MPCA)	City; County
Short Term Action Request (STAR) Grant	Minnesota's Costal Program Grant to help communities, agencies, and organizations balance protection of Lake Superior costal resources.	Minnesota Department of Natural Resources (MNDNR)	City; County; State Agency; Tribal; Watershed District
Stormwater Best Management Practices Loans	Offers low-interest loans for projects to control stormwater runoff. The loans offer incentives for installing infiltration-based stormwater quality practices.	Iowa Department of Agriculture and Land Stewardship (IDALS)	City; County; Private
Wellhead Protection Partner Grants	Establish protection of wellhead protection areas where state-held easements are not viable or desirable.	Minnesota Board of Water & Soil Resources (BWSR)	City; County

Table 16: Summary of Potential Funding Opportunities

Appendix: Hydrodynamic Separator Locations


13th Ave
1
8th St
9th St
12th Ave
Legend
Drainage Area
HDS Location
Storm Sewer
Catchbasins
0
100
Feet
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Stormwater Management Plan
Two Harbors, MN

Hydrodynamic Separator Location 2
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Stormwater Management Plan

Two Harbors, MN

Hydrodynamic Separator Location 3

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Stormwater Management Plan

Two Harbors, MN

Hydrodynamic Separator Location 4

January 2021

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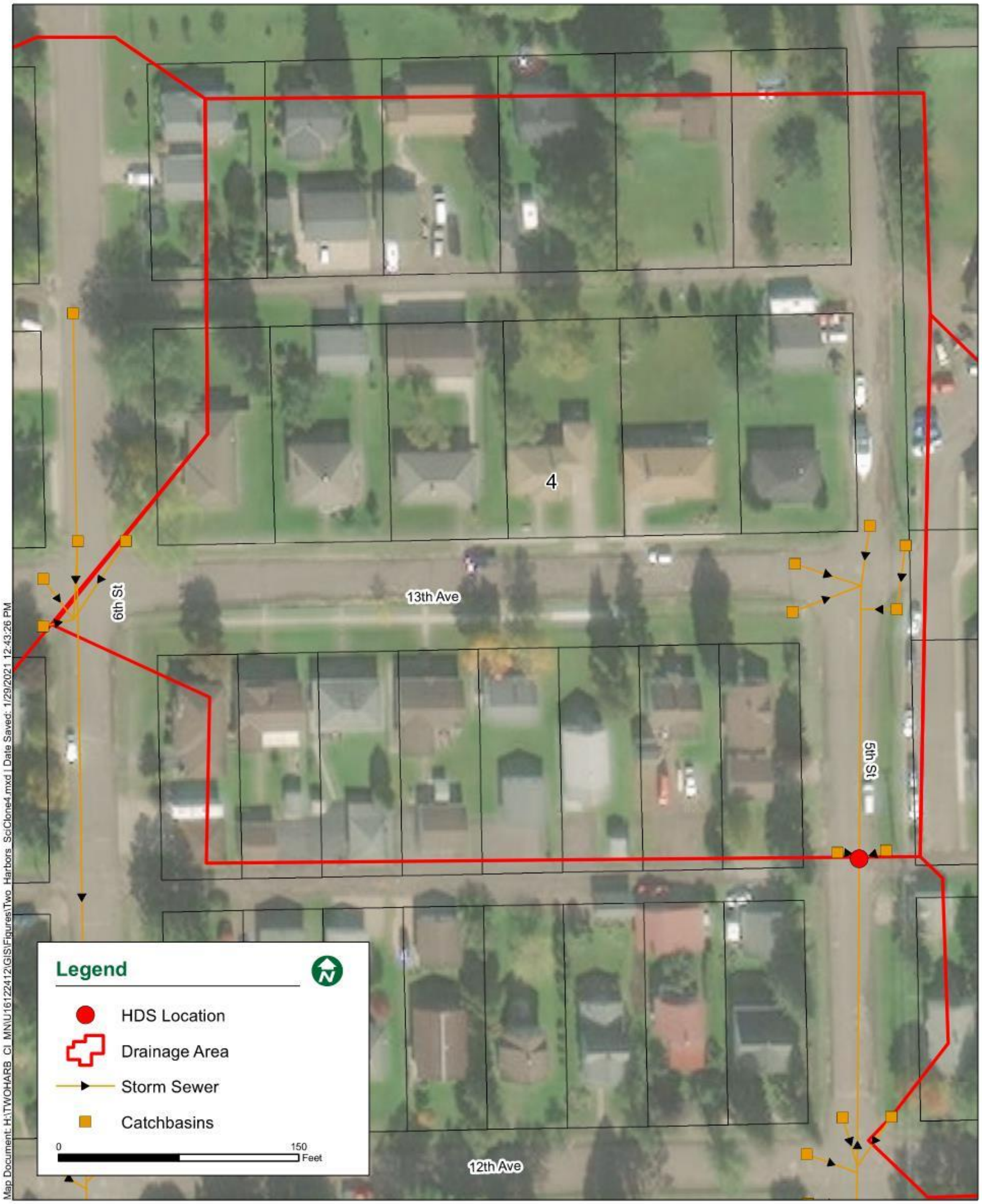

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Stormwater Management Plan

Two Harbors, MN

Hydrodynamic Separator Location 5

January 2021

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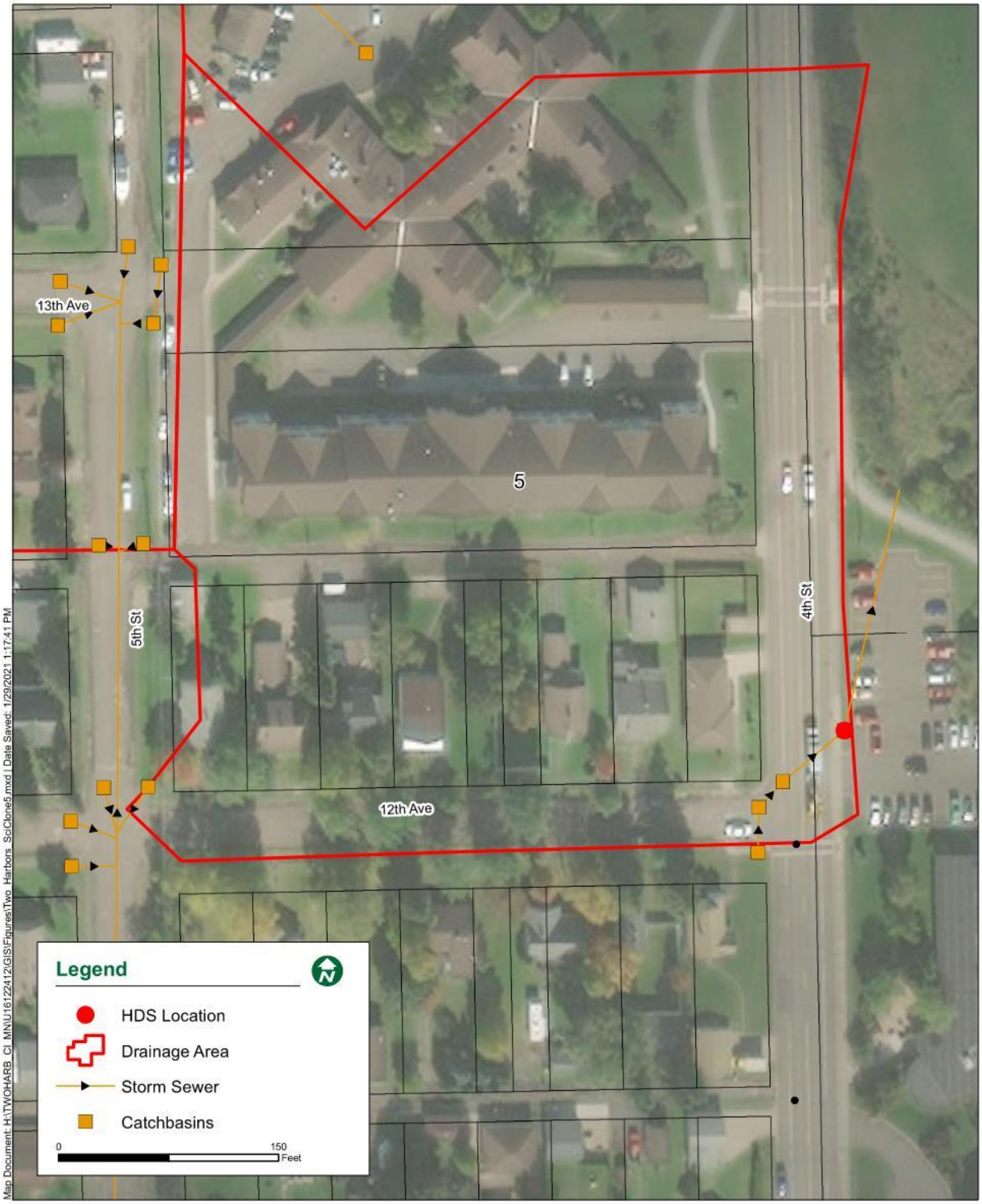

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Stormwater Management Plan
Two Harbors, MN

Hydrodynamic Separator Location 6
January 2021

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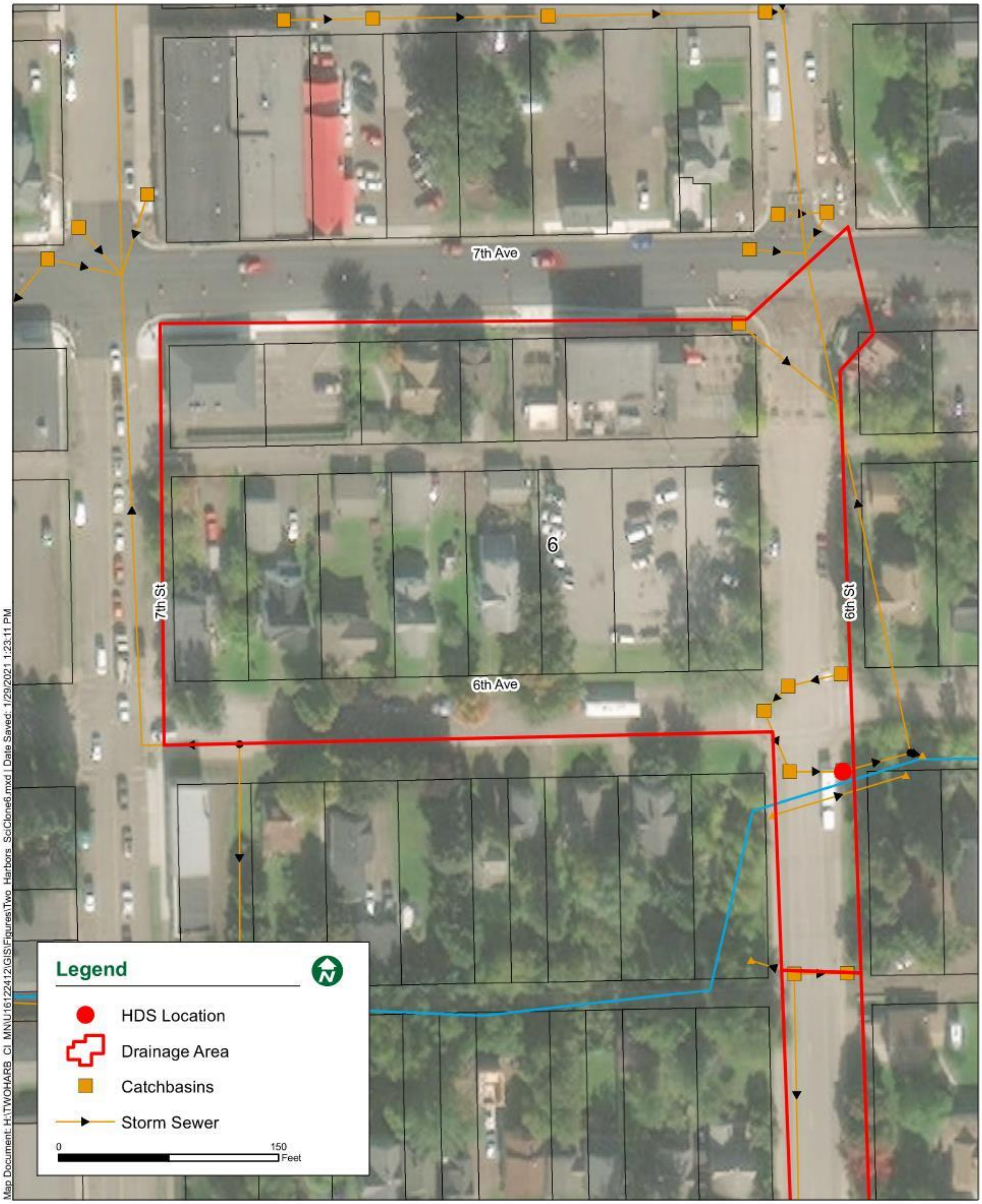

Hydrodynamic Separator Location 7

January 2021

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Services Provided:

Civil & Municipal Engineering
Water & Wastewater Engineering
Transportation Planning & Engineering
Structural Engineering
Aviation Services
Water Resources Engineering
Landscape Architecture
Land Surveying
Geographic Information System
Project Funding & Financing